INSTRUCTION MANUAL

for

MODEL LTU-2A RF TUNING UNIT

(TUNING RANGE: 940 MC to 1500 MC)

Polarad

Electronics Corporation

100 METROPOLITAN AVENUE BROOKLYN 11, N. Y.

Member of
"THE REPRESENTATIVES"
Sales Agency Manufacturers
CHICAGOLAND CHAPTER

NATIONAL 2-2370

LOREN F. GREEN & ASSOCIATES
Representing the Manufacturer

LEIGHTON C. ANDERSON
Sales Engineer

4949 West Diversey Avenue
CHICAGO 39, ILLINOIS

INSTRUCTION MANUAL

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MODEL LTU-2A RF TUNING UNIT

(TUNING RANGE: 940 MC to 4500 MC)

PART OF MODEL LSA ALL BAND, DIRECT READING SPECTRUM ANALYZER

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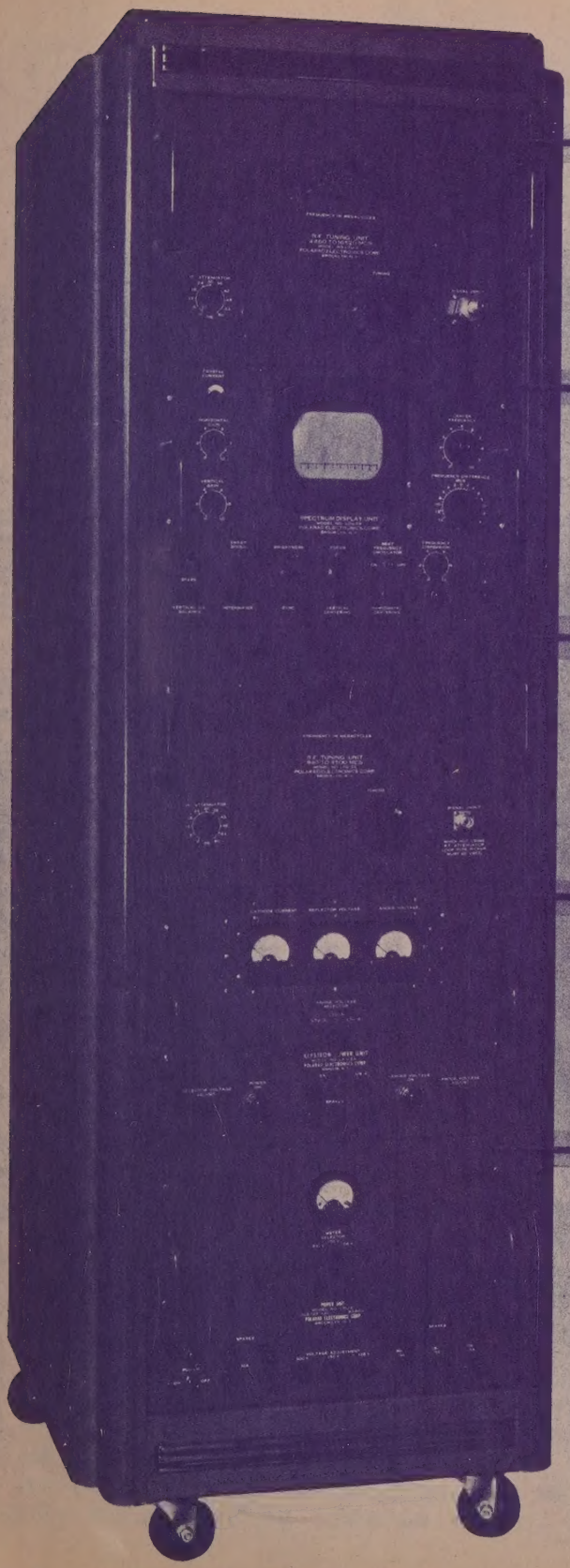

Figure 1. MODEL LSA SPECTRUM ANALYZER FRONT VIEW 1512-1
C

PART III

MODEL LTU-2A

RF TUNING UNIT

(940 Mc - 4500 Mc)

SECTION I

GENERAL DESCRIPTION

1. ORGANIZATION OF MANUAL

a. This instruction manual describes the Model LTU-2A RF Tuning Unit, which is a part of the Model LSA All-band Direct-reading Spectrum Analyzer, designed and manufactured by the Polarad Electronics Corporation of Brooklyn, N. Y. (See fig. 1). This manual describes the electrical and mechanical features of the RF Tuning Unit covering the frequency range from 940 mc to 4500 mc.

b. Since the Model LSA Spectrum Analyzer consists of several major units, it has been found desirable to divide the book into five major parts, to provide the most concise organization and presentation of the material. Part I contains descriptive and maintenance data for the basic units of the Spectrum Analyzer, which consist of the Model LDU-2A Display Unit, the Model LPU-2 Power Unit, and the Model LKU-2A Klystron Power Unit. Part II of the manual provides complete operational and adjustment data for the Model LTU-1 RF Tuning Unit, covering the frequency range from 9.5 mc to 1200 mc. Part IV is an operating and service manual for the Model LTU-3 RF Tuning Unit, covering the frequency range from 4460 mc to 16,520 mc. Part V performs the same function with respect to the Model LTU-4 Tuning Unit, covering the frequency range 15,000 mc to 21,000 mc, while the present manual, Part III, is applicable to the Model LTU-2A RF Tuning Unit only.

2. PURPOSE OF THE SPECTRUM ANALYZER

a. Polarad's Model LSA Spectrum Analyzer is a laboratory instrument which is used to provide a visual indication of the frequency distribution of energy in an rf signal in the range covered by the Tuning Unit in use. With the Model LTU-2A RF Tuning Unit connected to the basic units, radio signals in the frequency range from 940 mc to 4500 mc are converted to an intermediate frequency of 160 mc, at a power level sufficient to drive the various IF circuits located within the Model LDU-2A Display Unit. Signals received and detected by this Tuning Unit are presented visually as a plot of voltage, on the vertical axis, versus frequency, on the horizontal axis, of the oscilloscope within the Display Unit. Controls are provided on the Display Unit front panel for observing, on the cathode ray tube screen, a band of frequencies as narrow as 250 kc, adjustable continuously to a band as wide as 25 mc, as desired.

b. Specific applications of the Spectrum Analyzer consist of:

(1) Observing and measuring side bands associated with amplitude and frequency modulated signals;

(2) Determining the presence and accurately measuring the frequency of radio and/or radar signals;

(3) Determine type of modulation in radio and/or radar signals in any particular band;

(4) Checking and observing the tracking of rf components of a radar system, example, tracking transmitter and receiver;

(5) Determining rf pulse characteristics;

a. Frequency modulation
b. Pulse width
c. Pulse shape

} By Spectrum Analysis

(6) Checking the spectrum of pulsed magnetron oscillators, to determine pulse characteristics and check frequency pulling;

(7) Measure noise spectra;

(8) Checking the frequency difference of two close rf signals;

(9) Checking frequency relationships of multi-frequency transmitters, example, dmb transmitters;

(10) Comparing two pulses at same time;

(11) Checking for spurious response;

(12) Testing for interference sources throughout the frequency range from any electrical equipment;

(13) Checking transmitter or signal generator for continuous output throughout the band (checking for "holes");

(14) Drift of incoming signals;

(15) Leakage;

(16) Indicator for frequency standards (such as L band).

3. EQUIPMENT SUPPLIED

Figure 1 shows one of the RF Tuning Units in operation with the basic units of the Spectrum Analyzer, all mounted within the deluxe steel test-rack type cabinet. Viewed from the top of the rack to the bottom, the units consist of the RF Tuning Unit, the Model LDU-2A Spectrum Display Unit, the Model LKU-2A Klystron Power Unit, and the Model LPU-2 Power Unit. The equipment supplied with the Model LTU-2A RF Tuning is listed in table 1, below:

TABLE 1. EQUIPMENT SUPPL[illegible]

Polarad Model No.	Item	Description
LTU-2A	RF Tuning Unit (940 mc - 4500 mc range).	Mounted on rack panel, 12 1/2" high by 19" wide, by 21-3/4" deep.
	External RF adjustable Attenuator	Waveguide beyond cut-off attenuator; Calibrated range, 120 db; General Radio, Type 874M.
	Adaptors to type N connectors.	Used with rf attenuator. GR type 874-Q1 or GR type 874-QNP.
	50-ohm termination.	Used with rf attenuator, GR type 874-WM.
	Spanner wrench.	J. H. Williams and Co., type 482.
	Spline head wrench.	No. 6
	Allen wrench.	1/4-28

4. ELECTRICAL CHARACTERISTICS, MODEL LTU-2A TUNING UNIT

a. FREQUENCY CALIBRATION. -- The Model LTU-2A Tuning Unit tuning range is covered in two bands, both of which are inscribed on the calibrated tuning dial visible through the window at the top center of the front panel. The low band covers the frequency spectrum from 940 mc to 2160 mc; the high band covers the spectrum from 2040 mc to 4500 mc. The low and high band calibration curves are inscribed on the lower and upper sections of the tuning dial, respectively, as shown in figure 2.

b. OPERATING POWER REQUIREMENTS. -- Operating power for this tuning unit is supplied by two of the basic units of the Spectrum Analyzer equipment. The Model LPU-2 Power Unit supplies the 115-volt ac power for the filament transformer for the pre-amplifier tubes, the positive 105-volt dc potential for the plates and screen grid circuits of the pre-amplifier tubes, and the positive 150 v for the delay relay. The Model LKU-2A Klystron Power Unit supplies the 6.3 volt ac power for the heater of the reflex klystron tube, and the minus 325-volt and 425-volt potentials for the reflector and anode electrodes, respectively, of the reflex klystron tube.

5. PHYSICAL FEATURES.

The Model LTU-2A RF Tuning Unit contains an external cavity klystron local-oscillator, a crystal mixer, a 160 mc preamplifier, a filament transformer (protected by 1-ampere fuses in each input line), a tracking potentiometer adjustment panel, and a mechanical drive system. The unit is tuned manually by rotating the single TUNING knob, located at the center of the front panel, which simultaneously drives a non-contacting choke within the oscillator cavity, a tracking potentiometer for changing reflector voltage automatically, and a tuning dial which indicates frequency in megacycles on either of its two calibrated scales accurately to better than 1%. The chassis and oscillator housing are secured by means of bolts and nuts to a front panel which is painted in a gray satin finish. Two handles, located at the two sides of the front panel, are provided for ease

in pulling or replacing the Tuning Unit on its draw slides in the deluxe test rack supplied. At the rear of the unit are the two operating fuses, located within the extractor type fuseholders, the two spare fuses, and the panel receptacles for connection to the basic units. Refer to section II of this manual for a chart listing all controls, with their location and functions.

6. TECHNICAL SUMMARY, MODEL LTU-2A RF TUNING UNIT.

Frequency range:	
Low	940 mc to 2170 mc
High	2080 mc to 4300 mc.
Bandwidth	25 mc.
Sensitivity	Low range: -115 dbw. High range: -105 dbw.
Tube complement	1-5837; 7-6AK5; 1-6X4.
Power Input:	
DC	+150 +105v; -325 v; -925 v.
AC	6.3 vr 2 amperes; 115 v.
Tuning Dial accuracy	Better than 1%.
Attenuation:	
RF	120 db, external, continuously variable.
IF	60 db, in 6 db steps.
Input Impedance	50 ohms coaxial.

FIGURE 2 - MODEL LTU-2A RF TUNING UNIT

SECTION II

OPERATING INSTRUCTIONS

1. INTER-UNIT CABLING CONNECTIONS. (Refer to fig. 3)

a. Connect the Model LTU-2A RF Tuning Unit to the basic units of the Spectrum Analyzer as directed below:

(1) Connect the power cable W2, from the Power Unit TUNING HEAD connector, J2, on the equipment rear panel, to POWER receptacle J3001 on the Tuning Unit rear panel.

(2) Connect display signal cable, W5, from the Display Unit TUNING HEAD receptacle J302 to the DISPLAY receptacle J3002, on the Tuning Unit rear panel, right side.

(3) Connect klystron power cable, W4, from the Klystron Power Unit TUNING UNIT receptacle, J101, to the KLYSTRON POWER receptacle J3003, on the Tuning Unit rear panel.

(4) Connect the signal under measurement to the SIGNAL INPUT receptacle on the Tuning Unit front panel.

2. TABLE OF CONTROLS.

The following table lists the various operating controls located on the chassis. Location and function of each control and adjustment within the equipment is included.

TABLE 2. OPERATING CONTROLS AND ADJUSTMENTS

Control	Location	Function
TUNING	Front panel.	(1) When rotated, this control changes the position of the non-contacting choke located within the oscillator cavity, thereby resonating the cavity to the desired 3/4-wavelength mode.
		(2) At the same time, rotation of the TUNING control changes the position of the variable arm of tracking potentiometer R3008. This wire wound potentiometer determines the dc voltage applied to the reflector electrode of the klystron tube at a particular tuning dial setting.
		(3) At the same time, rotation of the TUNING control changes the position of the nylon cam. This cam activates microswitch S-3002.

		At the low end of the tuning dial, microswitch S-3002 is closed and the LOW MODE ADJ. control R-3001 is effective in tracking the oscillator through the 1 3/4 repeller mode. At the high end of the tuning dial, begining with an oscillator frequency setting of approximately 1430 mc, micro switch S-3002 is open and the HIGH MODE ADJ. control R-3013 is effective in tracking the oscillator through its 2 3/4 repeller mode. (4)Simultaneously, rotation of the TUNING control drives the tuning dial.
IF ATTENUATOR	Front Panel	Provides 60 db of attenuation, in nominal 6 db steps.
INCREASE CATHODE CURRENT R3011	Reflector control board, on rear of oscillator housing	Changes the bias potential applied to the control grid of the reflex klystron tube V3001.
HIGH LIMIT control R3002	Reflector control board, on rear of oscillator housing	Sets proper potential for tracking potentiometer at high end of the tuning range.
LOW LIMIT control R3009	Reflector control board, on rear of oscillator housing	Sets proper potential for tracking potentiometer at low end of the tuning range.
TRACK 1 control R3007	Reflector control board, on rear of oscillator housing	Sets proper value of tracking potentiometer at the 1030 mc calibration mark on the tuning dial.
TRACK 2 control R3006	Reflector control board, on rear of oscillator housing	Sets proper value of tracking potentiometer at the 1200 mc calibration mark on the tuning dial.
TRACK 3 control R3005	Reflector control board, on rear of oscillator housing	Sets proper value of tracking potentiometer at the 1540 mc calibration mark on the tuning dial.
TRACK 4 control R3004	Reflector control board, on rear of oscillator housing	Sets proper value of tracking potentiometer at the 1950 mc calibration mark on the low-band scale.

HIGH MODE ADJ. control R-3013	Reflector control board, on rear of oscillator housing	Sets proper value of potential applied to tracking control R3008 when nylon cam activates micro-switch S-3002 for high frequency repeller mode of operation. (Above approximately 1250 mc, dial frequency).
LOW MODE ADJ. control R-3001	Reflector control board, on rear of oscillator housing	Sets proper value of potential applied to tracking control R-3008 when nylon cam activates micro-switch S-3002 for low frequency repeller mode of operation. (Below approximately 1250 mc, dial frequency).
No. 6 spline head set screw	Bottom front of oscillator push plate	Locks oscillator push rod screw
Oscillator Push Rod Adjustment Screw	On lower front part of oscillator push plate	Controls the initial setting of the oscillator cavity length.

3. STARTING PROCEDURE.

a. Be sure that all inter-unit cable connections are properly made. (Refer to par. 1 in this section, and to fig. 3).

b. Turn the Power switch, located in the lower left section of the Model LPU-2 front panel, to its ON position, and allow a 10-minute warm-up period.

c. Check indications on the meters located on the Power Unit and Klystron Power Unit front panels, as described in Part I, Instruction Manual for the basic units.

d. Set controls on the Display Unit to produce a sweep base line, properly located on the screen, as described in Part I, Instruction Manual for the basic units.

e. Set the IF ATTENUATOR control to its zero setting.

4. OPERATING PROCEDURE.

a. To apply an rf signal to the Tuning Unit, connect the RF ATTENUATOR, supplied with the equipment, between the signal source and the SIGNAL INPUT jack, as directed in the instruction sheets attached to the rear of this manual. The external RF ATTENUATOR supplied is a General Radio, Type 874-QA attenuator, with accessories.

b. No difficulty is presented in determining which of the two calibrated scales on the tuning dial is to be read in operating the equipment; since the upper-scale range is approximately twice the frequency of the lower-scale range. In operation, signals in the lower band will appear to move across the Spectrum Display screen

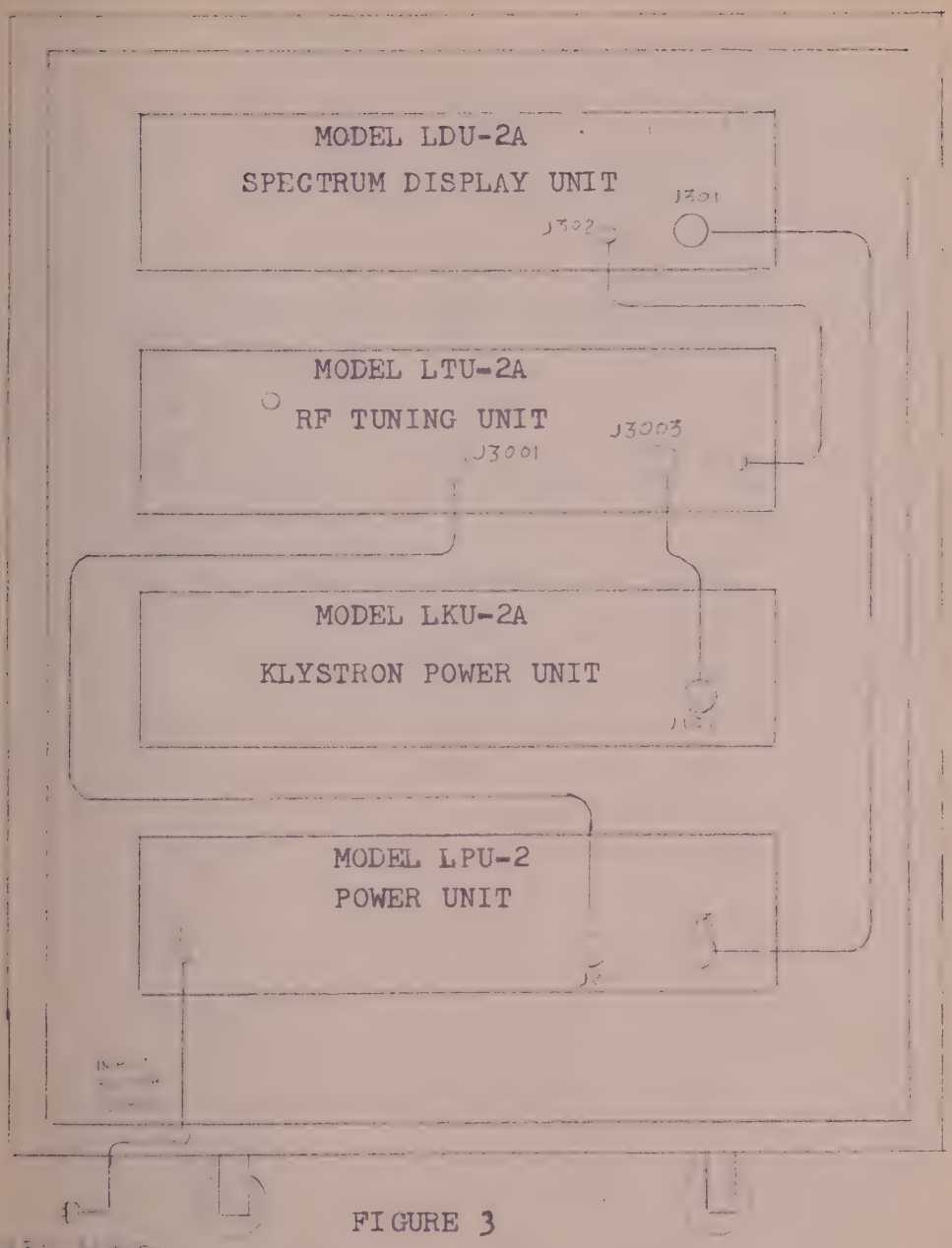

FIGURE 3

MODEL LSA SPECTRUM ANALYZER,
INTER-UNIT CABLING CONNECTIONS,
FOR 940 - 4,500 MCS

at twice the normal rate when the tuning dial is rotated, and the high band calibrated scale is read.

5. OPERATING PRECAUTIONS.

a. For proper use of the Model LFU-2A MF Tuning Unit, it is essential that true signal pips and image-frequency pips be distinguished. Apply a signal to the Tuning Unit and turn the TUNING knob until a pip appears on the screen. Then slowly tune the receiver up-scale. If the signal on the display screen moves towards the left, this is the true signal. Its frequency will then correspond to the appropriate tuning scale indication. If the signal moves towards the right, as the receiver is tuned up-scale, this is the image of the signal. The true signal will then be found 320 mc higher than the image signal on the tuning dial. Reference to the signal source will indicate approximately the range of signals applied to the Tuning Unit.

b. The CRYSTAL CURRENT meter, located on the Display Unit front panel, is used as an indicator to show that the klystron local oscillator is functioning. Disregard any numerical value of the calibrated scale, since the pointer deflection varies as the oscillator is tuned over the range of the Tuning Unit. Some indication of crystal current should appear for all frequencies on the tuning dial, but if toward the lower range of the Tuning Unit the meter should gradually move toward zero this can be disregarded. If at any point the meter abruptly drops to zero this is an indication that the oscillator is not functioning at this point and trouble shooting is required.

SECTION III

THEORY OF OPERATION

1. INTRODUCTION.

The Model LTU-2A Tuning Unit is one of four tuning units available with the Model LSA Spectrum Analyzer. This Tuning Unit receives signals in the range of 940 mc to 4500 mc. The range is covered in two bands, with the lower frequency range calibrated from 940 mc to 2160 mc, and the higher range calibrated from 2040 mc to 4500 mc. By means of manual tuning, signals in a 25 mc bandwidth, centered at the frequency to which the unit is tuned, are received, and converted to 160 mc (the first intermediate frequency). This 160 mc voltage is preamplified to improve signal-to-noise ratio, and is then fed by coaxial cable to the Display Unit. In the Display Unit, a second intermediate frequency of 64 mc is obtained by beating the 160 mc signal with the output of a sweeper circuit whose center frequency is 224 mc as it sweeps over the limits from 211.5 mc to 236.5 mc. Further on in the Display Unit circuitry is a fixed frequency of 90 mc oscillation which beats with the output of the 64 mc narrow band amplifier to produce a third beat frequency of 26 mc. Converter stages produce additional if.'s of 5 mc, and finally 455 kc. This kc signal is detected by a 12AT7 diode tube, the output of which is amplified and applied to the vertical plates of a display tube to appear as a pip, representing the voltage of the applied signal on the vertical axis, plotted against the band of frequencies covered by the output of the sweeper circuit on the horizontal axis. The following paragraphs, 2 through 5, describe the major assemblies within the tuning unit.

2. DETAILED FUNCTIONING. KLYSTRON OSCILLATOR.

a. A type 5837 tube is employed as the first local-oscillator. In the lower band of operation, the signal frequency is 160 mc lower than the local-oscillator (which oscillates over the range from 1100 mc to 2330 mc). In the higher band of operation (2040 mc to 4500 mc), the second harmonic frequency of the local-oscillator is used to heterodyne with an incoming signal. In this band, the signal frequency is 160 mc lower than the local-oscillator second harmonic frequency, which varies from 2200 mc to 4660 mc.

b. The external cavity Klystron oscillator in the present equipment functions with a 3/4 wavelength cavity mode. The oscillator is tuned by changing the position of a non-contacting short-circuiting choke assembly within the cavity and by changing the value of the reflector voltage. In the vicinity of 1430 mc, the reflector voltage becomes excessively high and mode-switching is therefore employed. The Model LTU-2A Tuning Unit employs the 1 3/4 reflector mode over the frequency range from approximately 940 mc to 1430 mc per second. At about 1430 mc a microswitch is activated by a nylon cam on the tracking potentiometer shaft reducing reflector voltage to the range proper for 2 3/4 reflector mode operation. A geared drive is employed in the tuning mechanism, rotation of the tuning dial drives the oscillator choke assembly. The voltage applied to the reflector electrode of the klystron tube is simultaneously tracked with the tuning dial rotation by means of a tracking potentiometer having

four equally spaced taps. The voltage at each tap is maintained at a proper level by a voltage divider network consisting of four potentiometers designated Track 1, Track 2, Track 3, and Track 4. Voltages at the limits of the tracking range are adjusted by two potentiometers designated HIGH LIMIT and LOW LIMIT respectively. Mode switching is employed (see above) to avoid excessive reflector voltage and the proper voltage range limits for each mode are provided by potentiometer adjustments designated HIGH-MODE and LOW-MODE respectively. All these potentiometer adjustments are mounted on a potentiometer tracking board on left rear of oscillator housing.

3. DETAILED FUNCTIONING, MECHANICAL DRIVE SYSTEM.

The drive system is a gear driven mechanism operating through two separate sets of gears. The tuning dial, whose shaft rotation is controlled by stops, is geared to the main drive shaft through an intermediate gear which in turn drives the main drive shaft, this gear chain introduces a ratio of approximately 20:1 between the tuning knob and the oscillator tracking potentiometer.

The main tracking potentiometer and the mode switching cam are driven through the main shaft (dial shaft) at the same ratio. The oscillator push plate, which drives the oscillator choke assembly, is driven through a set of gears which work off the main shaft.

4. DETAILED FUNCTIONING, CRYSTAL MIXER.

a. A type 1N21B silicon crystal diode is employed as the mixer, which developes a beat signal of 160 mc when the fundamental frequency of the klystron oscillator and the applied signal in the low band range of the tuning unit are coupled to its input. For example, when an rf signal of 940 mc is applied through the SIGNAL INPUT jack to the crystal mixer, the klystron oscillator is tuned to produce an output voltage of 1100 mc. The resultant difference frequency of 160 mc at the output of a stagger-tuned if. pre-amplifier. The 160 mc voltage is amplified in this circuit to a level suitable for the mixing and amplifying functions performed by the if. circuits in the Model LDU-2A Display Unit.

b. In operating the Tuning over its high-band range, the second harmonic of the klystron oscillator frequency is used to beat with the incoming rf signal. This second harmonic component is actually developed in the crystal mixer, due to the mixer's non-linear characteristics. For example, when the Tuning Unit is tuned to signal frequency of 2040 mc, the fundamental local oscillator frequency is 1100 mc. This second harmonic of the oscillator frequency is then 2200 mc. This second harmonic component beats with an incoming 2040 mc signal to produce a difference frequency of 160 mc, which is fed to the pre-amplifier.

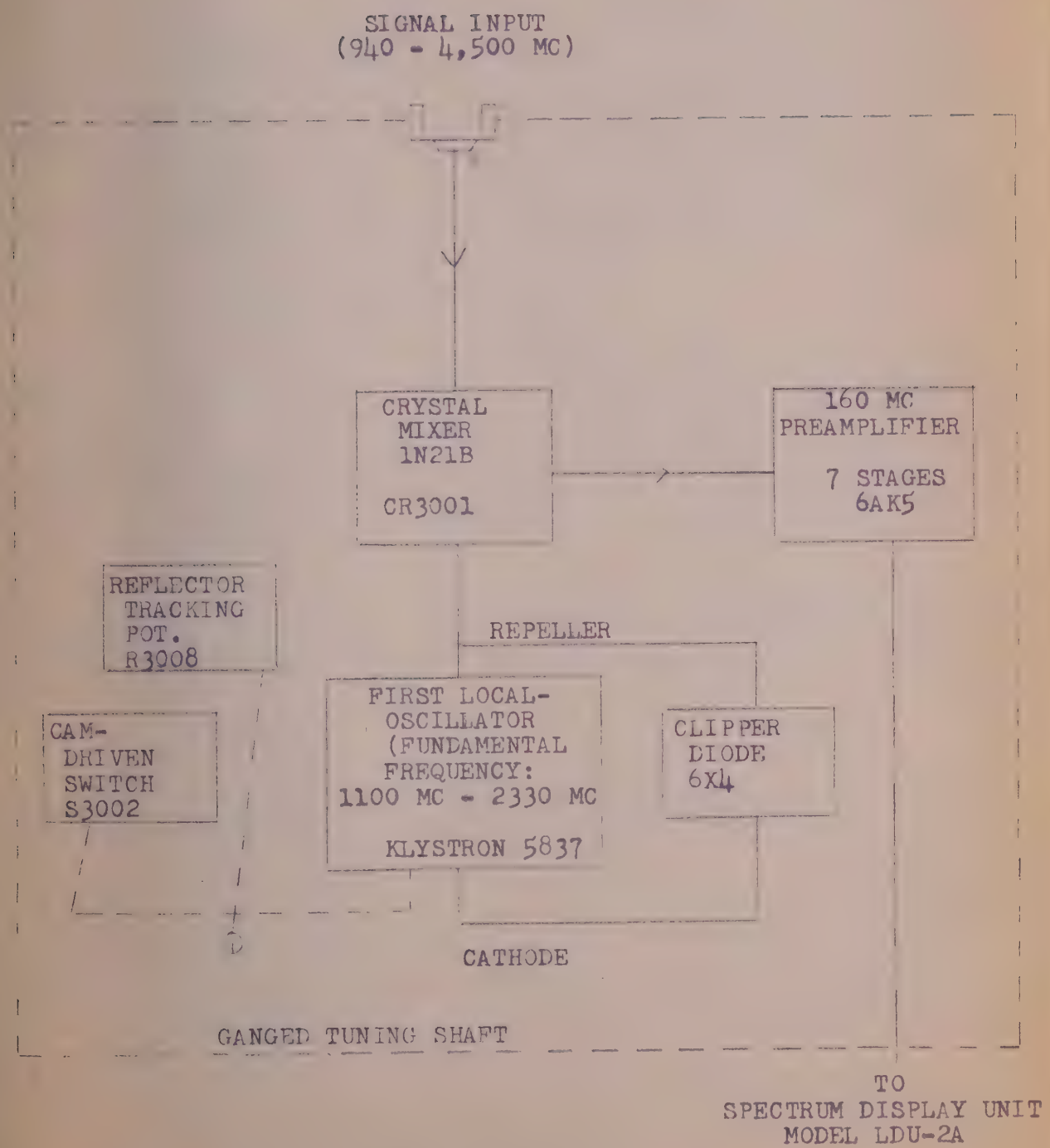

FIGURE 4

RF TUNING UNIT, MODEL LTU-2A BLOCK DIAGRAM

5. DETAILED FUNCTIONING, PREAMPLIFIER.

The if. preamplifier receives signals from the crystal mixer at a frequency of 160 mc, and amplifies them to such a level that they may be transmitted through a coaxial cable to the Spectrum Display Unit without introducing additional noise. The preamplifier amplifies signals in a band 28 mc wide, centered at 160 mc. It contains seven type 6AK5 tubes. The first tube V1301 acts as an impedance transformer matching the input of the preamplifier to the output of the crystal mixer. Tubes V1302 through V1304 comprise a stagger-tuned triplet, while tubes V1305 through V1307 make up the second triplet. The first stage in each triplet is tuned to the center of the pass-band at 160 mc, the second stage is tuned to 175 mc, and the final stage is tuned to 146 mc. The IF ATTENUATOR varies the cathode impedance of the first triplet. The 6 db steps of if. attenuation, ranging from 0 to 60 db, are provided to control the sensitivity of the receiver.

6. POWER SUPPLY CIRCUIT

a. Operating power for the Tuning Unit is obtained from the Power Unit and Klystron Power Unit by inter-unit cabling connections. The Klystron Power Unit supplies all necessary voltages for the klystron tube operation. The Power Unit supplies the positive 105-volt potential for the plate and screen grids of the 6AK5 amplifiers, and the +150 v for the delay relay. It also provides the 115-volt ac power for the filament transformer and passes 115-v ac on to power the Klystron Power Unit, Model LKU-2A.

b. The filament transformer T3001 is mounted on the right rear of the pre-amplifier mounting plate. The 6.3 volt ac output from the transformer is used as heater power for the preamplifier and for pilot lamps E3001 and E3002 which illuminate the tuning dial when power is applied.

NOTE

An I-F attenuation table is provided with each Model LTU-2A RF Tuning Unit supplied.

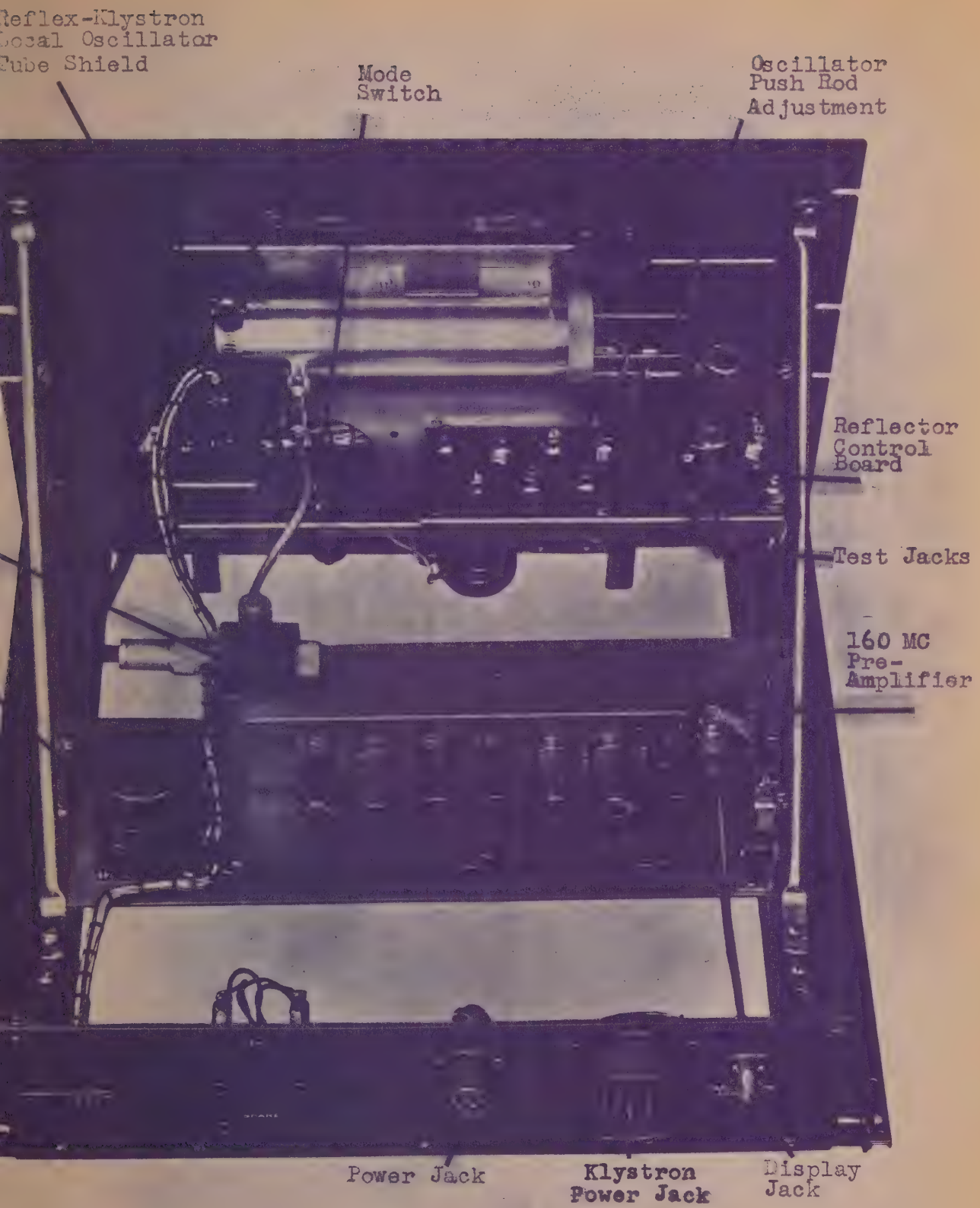

FIGURE 5 - MODEL LTU-2A RF TUNING UNIT
TOP VIEW

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FIGURE 5
MODEL LTU-2A RF TUNING UNIT
TOP VIEW

SECTION IV

MAINTENANCE

4-1. GENERAL.

a. This section covers corrective maintenance for the Model LTU-2A RF Tuning Unit. Included are instructions for replacing the klystron oscillator tube and the alignment procedure required after installing a new klystron tube.

b. The material contained in this section is to be used in conjunction with the schematic circuit diagram appearing at the rear of this manual. Specific reference to this diagram is made throughout the text, where applicable.

4-2. PRE-OPERATIONAL CHECKS AND ADJUSTMENTS.
(Refer to figure 5.)

a. The Instruction Manual, Part I, for the Model LSA Spectrum Analyzer gives complete pre-operational checks and adjustment procedures for the basic units. The following directions apply to the Model LTU-2A (940-4500 mc) Tuning Unit only, and should be performed after all checks and adjustments to the basic units are completed:

(1) Examine all tubes in the 160 mc preamplifier to see that they firmly seated in their tube sockets.

(2) Check that switch action of the IF ATTENUATOR S3001 is firm and positive for each of its 11 positions. Set the IF ATTENUATOR to its 0 db position, after performing the check.

(3) Check that rotation of TUNING knob throughout its range in both clockwise and counterclockwise rotation is smooth and continuous; the knob must be tight on its shaft.

(4) Examine all plugs and connectors to see that they are firmly seated and screwed tight.

(5) With operating power OFF, check that the klystron protective cover, on the right side of the oscillator cavity, is firmly in place.

WARNING

Application of power to this Tuning Unit results in very high voltages which are dangerous to life. Personnel must observe all safety precautions at all times. Do Not attempt to remove the klystron tube from its cavity when operating power is applied.

(6) After connecting all cables to the tuning unit, throw the POWER switch on the Model LPU-2 Power Unit of the Spectrum Analyzer to its ON position. The tuning dial will become illuminated. Energizing of the tuning dial lamps indicates that 115-volt ac power is applied to the Tuning Unit, and that the filament transformer is developing 6.3-volt output.

3. REPLACEMENT OF OSCILLATOR TUBE.

(Refer to figure 5)

a. A type 5837 tube is used as the reflex klystron oscillator in this tuning unit. The klystron tube is partially seated within the right end of the oscillator cavity, which is assembled on the housing directly to the rear of the equipment front panel. If replacement of the oscillator tube is necessary, proceed as follows:

(1) BE SURE TO TURN OPERATING POWER OFF. Throw the POWER switch on the Model LPU-2 Power Unit to the OFF position. In addition, remove Klystron Power Unit cable W4 from KLYSTRON POWER receptacle J303 at the Tuning Unit rear panel. Also remove Power Unit cable W2 from POWER receptacle J3001 at the Tuning Unit rear panel.

(2) Remove the breeze clamp holding the klystron protective cover to the klystron retainer nut and slide the cover back along the socket lead cable.

(3) Gently pull the tube socket assembly away from the base of the klystron tube.

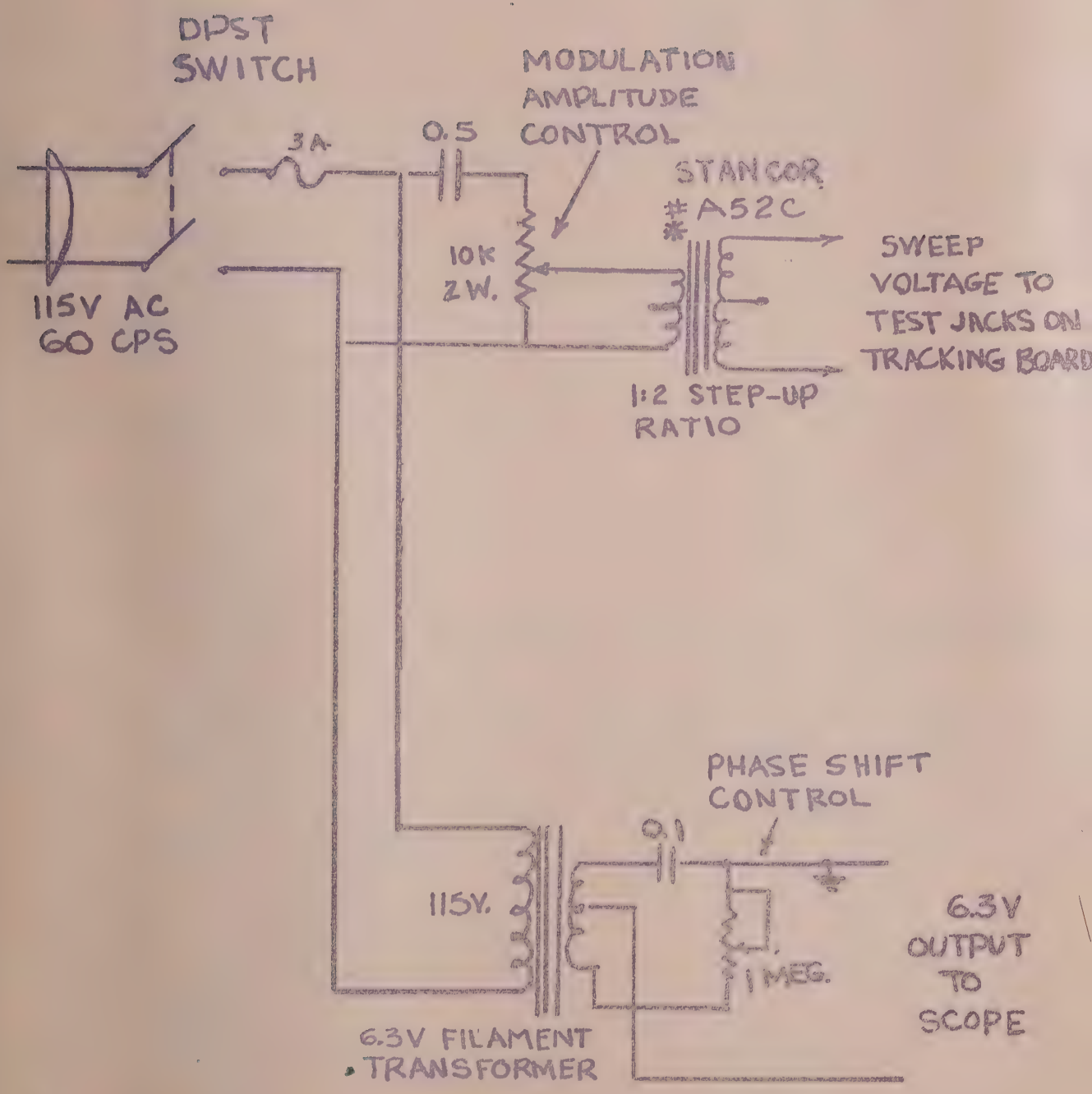
(4) Use the spanner wrench supplied with the equipment to loosen the knurled collar at the end of the cavity. DO NOT REMOVE THE COLLAR COMPLETELY.

(5) Grasp the projecting end of the klystron tube, gently rotating it in a clockwise direction while simultaneously withdrawing the tube from its spring finger holders within the cavity.

b. To replace a new 5837 tube in the cavity, proceed as follows:

(1) Insert the tube carefully within the center of the cavity, and press it all the way in against a noticeable resistance as the internal contact ring-fingers make engagement, until it meets a positive stop.

(2) Then re-tighten the large knurled collar, using the spanner wrench.



* DENOTES INSULATION BETWEEN WINDINGS AND CORE IS 2,000V RMS

Figure 6. Phase Shifting Circuit, Schematic Diagram

(3) Connect the socket to the base of the klystron tube. Use care to avoid breaking or bending the tube pins as the socket can be forced on in the wrong position (the tube will not operate in this case). (Pin No. 1 is the pin apart from the other three).

(4) Replace the klystron protective cover by clamping it in place with the breeze clamp.

(5) Reconnect Power Unit cable W2 and the Klystron Power Unit cable W4 to the appropriate receptacles on the equipment rear panel. Throw the POWER switch on the Model LTU-2 Power Unit to its ON position. Allow a ten-minute warm-up period. Then re-align the tuning unit, as directed below.

4. ALIGNMENT PROCEDURE.

(This assumes the unit was previously aligned and operating but the klystron was changed.)

a. Equipment required:

1-Signal Generator covering the input range of the Model LTU-2A Tuning Unit.

2-Modulator

3-High gain oscilloscope

b. Preliminary procedure

(1) With the Power off connect the modulator to the reflector test jacks and the scope as shown in figure 6.

(2) Connect the output of the crystal mixer to the vertical input of the oscilloscope, on the Model LTU-2A the output is available at pin B of plug P3007, and proceed with steps outlined in Table 3.

Table 3. MODEL LTU-2A TUNING UNIT ALIGNMENT PROCEDURE

Step	Adjustment	Adjustment Location	Proper Indication
1.	Rotate the INCREASE CATHODE CURRENT screw driver control to its extreme counterclockwise position.	Reflector control board on oscillator housing	None
2.	Set POWER switch to ON position, and wait approximately 1-minute for the delay-relay in the Klystron power unit to complete its cycle.	Front Panel of power unit	a. All pilots light b. Meter pointer on Power Unit panel deflects to an on-scale indication, depending on the position of the METER SELECTOR. d. After the one-minute delay period the pointers of the three meters on the Klystron Power Unit deflect as given below:

Adjustment	Adjustment Location	Proper Indication
		CATHODE CURRENT on scale REFLECTOR VOLTAGE 600 ANODE VOLTAGE 325
Connect the negative terminal of a D.C. Voltmeter to pin 1 of R3011, the INCREASE CATHODE CURRENT pot, and the voltmeter positive terminal to pin 3 of the pot. Adjust the INCREASE CATHODE CURRENT control clockwise until the voltmeter reads 10 volts. The CATHODE CURRENT meter should read between 18 ma and 22 ma.	Reflector control board on rear of oscillator housing.	D.C. Voltmeter reads 10 V.
Rotate the Tuning Knob to the low-frequency end of the tuning dial.	Tuning Unit front panel.	940 mc calibration mark, on the lower scale, appears under the index hairline.
Increase the Modulation Amplitude and adjust the phase control	Modulator Unit	A single mode pattern appears on the screen.
Adjust the LO LIMIT screw driver control.	Reflector control board on rear of oscillator housing.	The mode moves to the center of the screen.
Rotate the Tuning Knob to the high end of the tuning dial.	Tuning Unit front panel.	2160 mc calibration mark, on the lower scale, appears under the index hairline.
Adjust the Modulation Amplitude and phase control pots.	Modulator Unit	A single mode pattern appears on the screen.
Adjust the HI-LIMIT screw driver control	Reflector control board on rear of oscillator housing.	The mode moves to the center of the screen

Adjustment	Adjustment Location	[illegible]
Rotate the Tuning Knob to the low frequency side of the mode switch just after it clicks.	Tuning Unit front panel.	Approx. 1250 mc calibration mark, on the lower scale appears under the index hairline.
Adjust the modulation amplitude and phase control pots.	Modulator Unit	A single mode pattern appears on the screen.
Adjust LO-MODE screw driver control.	Reflector control board on rear of oscillator housing.	The mode moves to the center of the screen.
Rotate the Tuning Knob to the high frequency side of the mode switch, just after it clicks.	Tuning Unit front panel.	Approx. 1250 mc calibration mark, on the lower scale, appears under the index hairline.
Adjust the Modulation Amplitude and phase control pots.	Modulator Unit	A single mode pattern appears on the screen.
Adjust the HI-MODE screw driver control	Reflector control board on rear of oscillator housing	The mode moves to the center of the screen.
Rotate the Tuning Knob to 1030 mc on the lower scale.	Tuning Unit front panel.	1030 mc calibration mark, on the lower scale, appears under the index hairline.
Adjust the Modulation Amplitude and phase control pots.	Modulator Unit	A single mode pattern appears on the screen.
Adjust the TRACK 1 screw driver control	Reflector control board on rear of oscillator housing	The mode moves to the center of the screen.
Rotate the Tuning Knob to 1200 mc on the lower scale.	Tuning Unit front panel.	1200 mc calibration mark, on the lower scale, appears under the index hairline.
Adjust the Modulation Amplitude and phase control pots.	Modulator Unit	A single mode pattern appears on the screen.

Adjustment	Adjustment Location	Proper Indication
Adjust the TRACK 2 screw driver control	Reflector control board on rear of oscillator housing.	The mode moves to the center of the screen.
Rotate the Tuning Knob to 1540 mc on the lower scale	Tuning Unit front panel.	1540 mc calibration mark, on the lower scale, appears under the index hairline.
Adjust the Modulation Amplitude and phase control pots.	Modulator Unit	A single mode pattern appears on the screen.
Adjust the TRACK 3 screw driver control	Reflector control board on rear of oscillator housing.	The mode moves to the center of the screen.
Rotates the Tuning Knob to 1950 mc on the lower scale.	Tuning Unit front panel.	1950 mc calibration mark, on the lower scale, appears under the index hairline.
Adjust Modulation Amplitude and phase control pots.	Modulator Unit.	A single mode pattern appears on the screen.
Adjust the TRACK 4 screwdriver control.	Reflector control board on rear of oscillator housing.	The mode moves to the center of the screen.
Repeat steps 4 through 27 until no further adjustment is required.	Tuning Unit front panel, reflector control board and Modulator unit.	The modes remain centered at all reference points.
Disconnect the Modulation Unit, scope and voltmeter from the unit and insert plug P3007 in its socket. Connect the Signal Generator to the SIGNAL INPUT JACK, Turn the BEAT FREQUENCY OSCILLATOR ON-OFF switch to its ON position, set the FREQUENCY DIFFERENCE MCS knob to the zero mc position and turn the FREQUENCY DISPERSION knob to the ten position.	Tuning Unit front panel and Spectrum Display Unit front panel	A pip from the BEAT FREQUENCY OSCILLATOR should appear on the center of the screen of the Spectrum Display Unit. If not adjust the center frequency control until the pip is centered.

Adjustment	Adjustment Location	Proper Indication
Rotate the Tuning Knob to the high frequency end of the tuning dial, 2160 mc on the lower scale, and tune the Signal Generator tuning dial to the same frequency.	Tuning Unit front panel and Signal Generator tuning dial	A second pip appears on the Spectrum Display Unit screen.
Tune the signal generator so that the pips coincide	Signal Generator front panel	Record signal generator frequency (actual frequency) as against dial frequency.
Repeat steps 30 and 31 for all frequencies indicated on the low scale of the tuning dial from 2160 to 940 mc	Tuning Unit front panel and Signal Generator front panel	The true frequency should be within 1% of the dial frequency at all points. If not, proceed to step 34.
Recheck steps 30 through 32	Tuning Unit front panel and Signal Generator front panel	Pips should coincide, with actual frequency within 1% of the dial frequency at all points.
Set the Power switch to its OFF position.	Power Unit front panel	All pilots and tuning dial lights go out.
Loosen the No. 6 set screw which locks the push rod adjustment screw.	Bottom front of the oscillator push plate	None
Set the Power switch to its ON position.	Power Unit front panel	All pilot and Tuning dial lights go on
With the tuning dial of the Tuning Unit and the Signal Generator set at 2160 mc adjust the oscillator push rod adjustment by means of a 1/4" Allen wrench	On lower front part of the oscillator push plate	The Input Signal Pip and the pip from the BEAT FREQUENCY OSCILLATOR coincide.

Adjustment	Adjustment Location	
Lock the Oscillator push rod Adjustment Screw in place by tightening the No. 6 set screw.	Bottom front of the oscillator push plate.	The modes should be centered, the pips should remain coincidental.
Repeat steps 1 through 33 and the preliminary procedure.		Tuning Unit should be accurately calibrated.

5. PREAMPLIFIER ALIGNMENT.

a. The preamplifier of the Model LTU-2A Tuning Unit is located behind the oscillator cavity, and is positioned with the tubes in a horizontal plane. The preamplifier sub-chassis is supported by an aluminum angle plate which is secured to the main frame, by means of mounting screws. To remove the preamplifier sub-chassis for alignment, unscrew the four mounting screws (two at each side) which hold the mounting feet of the sub-chassis to the metal angle plate. Disconnect the RG-71/U cable termination, P3008, from the XTAL MIXER INPUT receptacle J3008, on the top left side of the sub-chassis. Do not remove the other cable connections. Proceed as directed below:

(1) Use a signal generator within the frequency ranges from 146 mc to 175 mc as the signal source.

(2) Connect the output cable of the signal generator through a suitable pad (providing at least 6 db attenuation) directly into the XTAL MIXER INPUT jack J3008, located at the top left side of the preamplifier.

(3) Be sure that the multi-conductor cable terminating in plug P3007 is making good electrical contact with the vertically mounted receptacle J3007, located below and to the right of the oscillator housing. Also check that inter-unit cable W5 connects the signal output at DISPLAY UNIT jack J3002, on the rear panel, to TUNING HEAD jack J302, on the Spectrum Display Unit. With the cables connected as directed, align the preamplifier by observing the signal pip on the screen of the Display Unit.

(4) If desired, an rf voltmeter may be used as the indicating device in this alignment procedure, instead of utilizing the spectrum display. In this case, disconnect cable W5 from the DISPLAY UNIT jack J3002. Connect the rf voltmeter to J3002 through a 50-ohm terminated cable.

NOTE

If an rf voltmeter is used at the output of the preamplifier, vary the signal generator output level control so that a voltmeter indication no greater than 0.4 volt is obtained throughout the alignment procedure.

b. SIX-STEP PROCEDURE: -- Allow the signal generator and the preamplifier a 15-minute warm-up period; then follow the steps outlined immediately below:

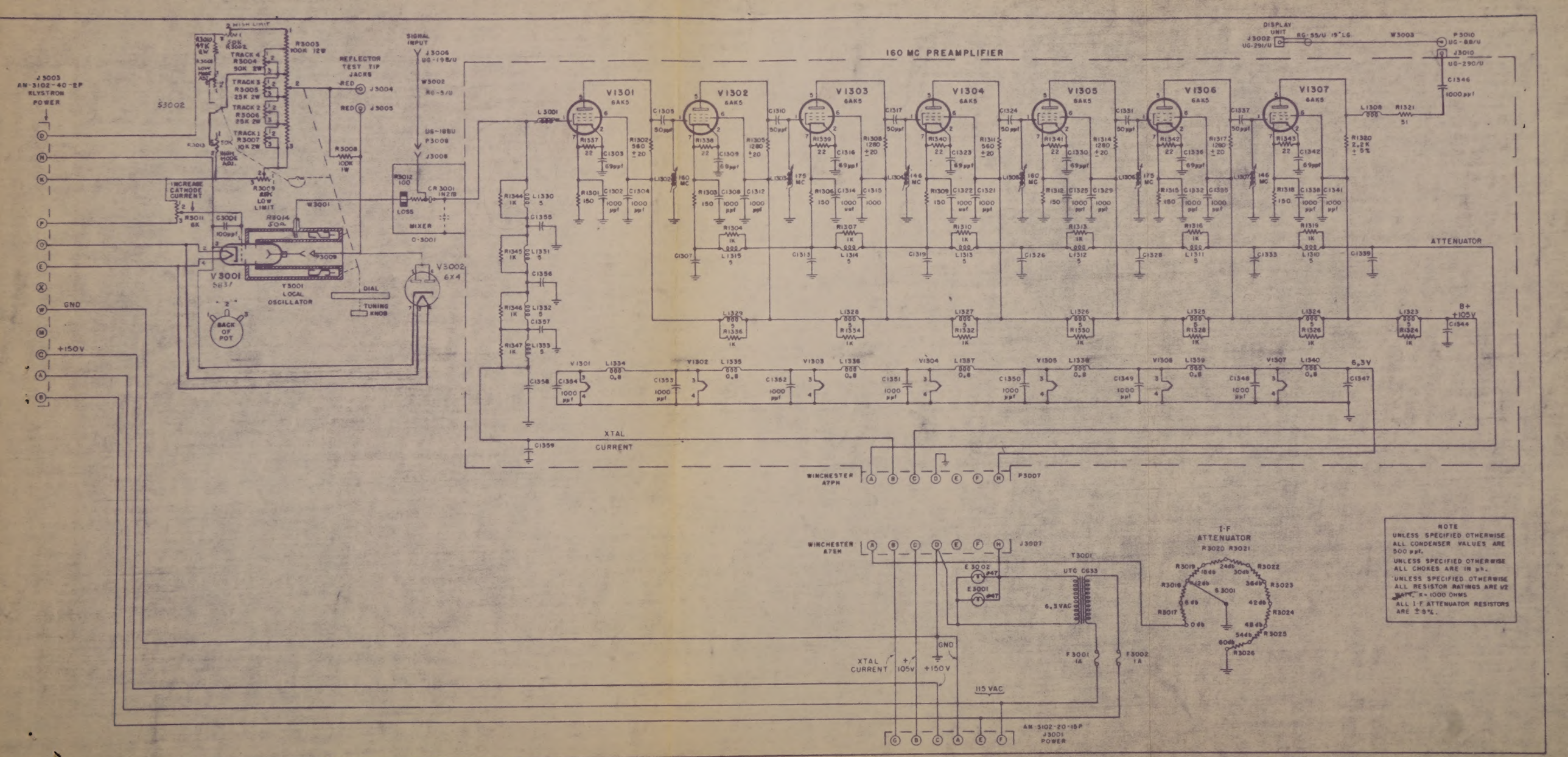
(1) Set the controls on the signal generator to produce a cw signal of 146 mc, and tune the two adjustment screws marked 146 mc (L1304 and L1307) until maximum output is obtained on the spectrum display screen, or on the rf voltmeter.

(2) Set the controls on the signal generator to produce a cw output frequency of 175 mc, and tune the two adjustment screws marked 175 mc (for L1303 and L1306) until maximum output is obtained.

(3) Set the controls on the signal generator to produce a cw output frequency of 160 mc, and tune two of the three adjustment screws marked 160 mc (for L1302 and L1305) until maximum output is obtained. The adjustment screw for L3001, located to the left of the first amplifier tube V1301, as viewed from the top of the sub-chassis, is adjusted as directed in step (5) below.

(4) After completing steps (1) through (3) above, the preamplifier preliminary alignment is completed. For optimum adjustment, however, its response should be checked. Construct a response curve, by varying the output of the signal generator over the range from 146 to 175 mc, noting the output voltage at several frequencies. If necessary, slightly re-tune the 160 mc inductors L1302 and L1305. At the 3 db points, the bandwidth of the preamplifier is approximately 28 mc, with a voltage gain of approximately 10 (20 db), for an input signal of 0.02 volt.

(5) To tune input inductor L3001, in the grid circuit of the first amplifier tube V1301, disconnect the signal generator output cable from XTAL MIXER INPUT jack J3008 and re-connect coaxial cable W3002 from the crystal mixer assembly CR3001 to the XTAL MIXER INPUT jack. Apply a test signal to the Tuning Unit through the external RF Attenuator if the signal power level is greater than 1 milliwatt, and rotate the TUNING DIAL to the same frequency as the signal source. Rock the TUNING dial until the pip representing the detected test signal appears at the center of the Spectrum Display Unit screen. Tune the variable input inductor L3001 critically by rocking its adjustment screw until maximum response, on the screen, is obtained.



POLARAD ELECTRONICS CORP.

TUNING UNIT (PART OF SPECTRUM ANALYZER) SCHEMATIC
DIAGRAM 940-4500 MC, MODEL LTU-2-A